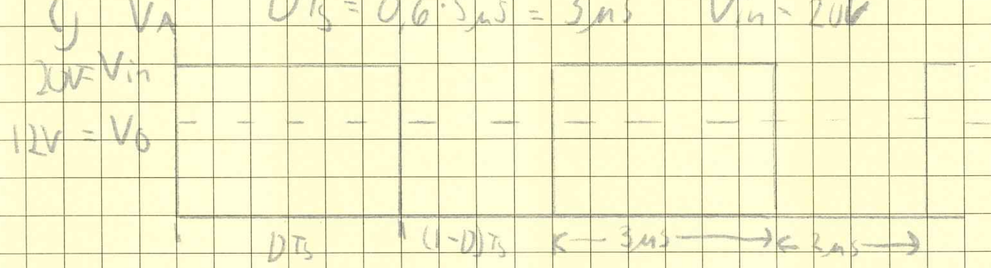
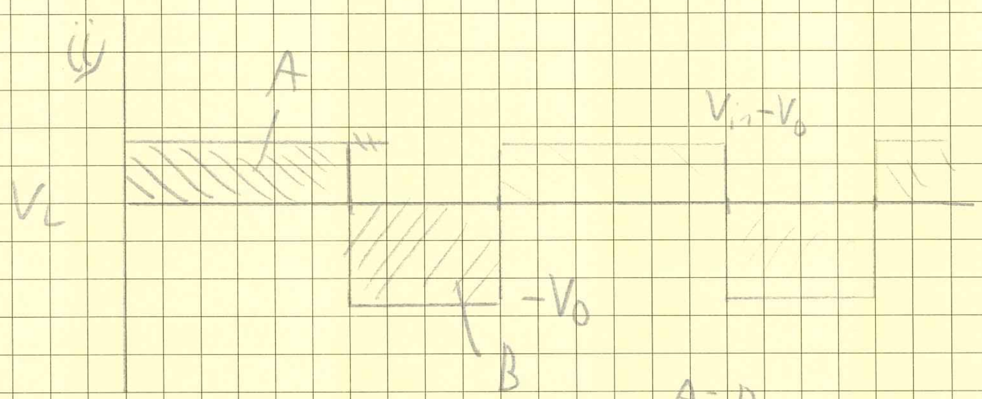
$L = 24\mu H$ $P_0 = 14W$ $T_S = \frac{1}{200\cdot 10^3} = 5\mu S$

1 a) (i) V_A $DT_S = 0,6\cdot 5\mu S = 3\mu s$ $V_{in} = 20V$



$V_0 = DV_{in} = 20\cdot 0,6 = 12V$

(ii)



A = B

(iii) and (iv)

$\Delta i_L = \frac{1}{L} DT_S\cdot(V_{in}-V_0) = \frac{1}{L}(1-D)T_S V_0$

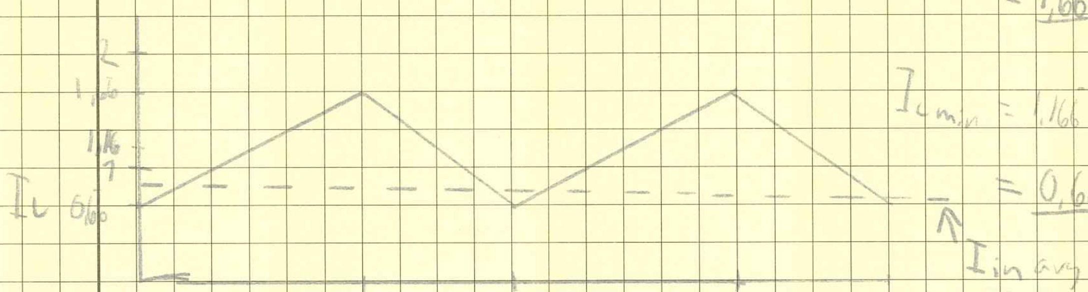
$I_{in} = \frac{P_{in}}{V_{in}} = \frac{P_0}{V_{in}} = \frac{14}{20}$

$\Delta i_L = \frac{1}{24\cdot 10^{-6}}\cdot 0,6\cdot 5\cdot 10^{-6}(20-12) = \underline{1A}$

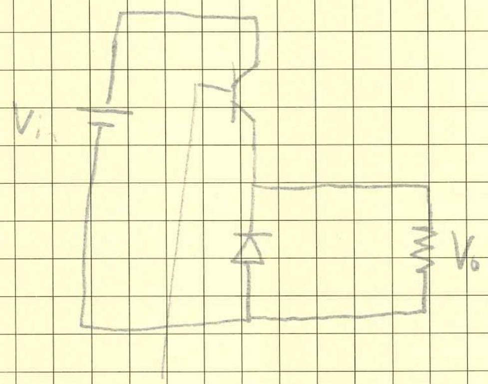
avg: $I_L = I_0 = \frac{P_0}{V_0} = \frac{14}{12} = 1,1\bar{6}$

$I_{L\,max} = 1,1\bar{6} + \frac{\Delta i_L}{2} = 1,1\bar{6} + 0,5 = \underline{1,6\bar{6}\,A}$

$I_{L\,min} = 1,1\bar{6} - \frac{\Delta i_L}{2} = 1,1\bar{6} - 0,5 = \underline{0,6\bar{6}\,A}$



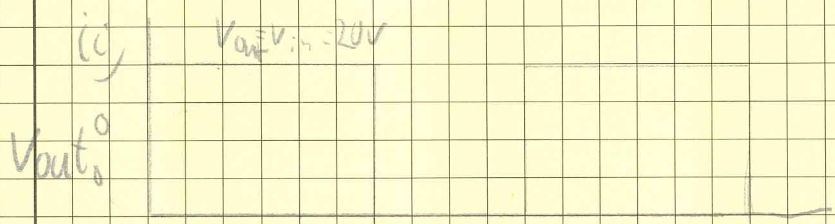
1 b



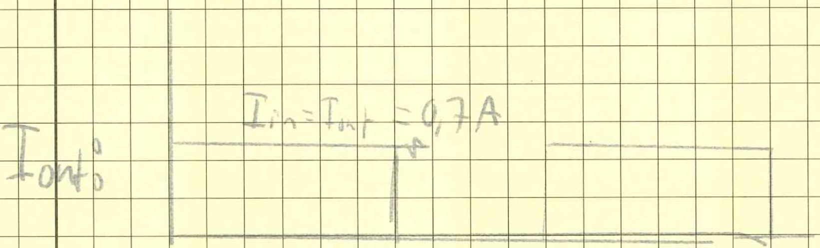
i) The free-wheeling diode does nothing

Because when there is no inductor, there is no energy stored. So when the transistor is off, there is no power in the circuit.

ii)



$$I_{out} = I_{in} = \frac{P_o}{V_{in}} = \frac{14}{20} = 0{,}7$$



$$V_o\ avg = \frac{V_{in} \cdot D + ((1-D) \cdot 0)}{1} = V_{in} \cdot D = \underline{12V}$$

$$I_o\ avg = \frac{I_{in} \cdot D + ((1-D) \cdot 0)}{1} = I_{in} \cdot D = 0{,}7 \cdot 0{,}6 = \underline{0{,}42 A}$$

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1.

b) iv) rms: root mean square

$$\cancel{V_{out\,rms} = \sqrt{\frac{V_{in}^2}{D} \cdot D}}$$

root: $(V_{in} D)^2$ ⇒ mean $\frac{(V_{in} D)^2}{D}$

squared ⇒ $\sqrt{\frac{V_{in}^2 D^2}{D}}$

$$V_{out\,rms} = \sqrt{\frac{(V_{in} D)^2}{D}} = \sqrt{\frac{V_{in}^2 D^2}{D}} = \sqrt{V_{in}^2 D} = \underline{\underline{V_{in}\sqrt{D}}}$$

We know $I = \frac{V}{Z}$ Since there is only R ⇒ $I = \frac{V}{R}$

$$\underline{\underline{I = \frac{V_{in}\sqrt{D}}{R}}}$$

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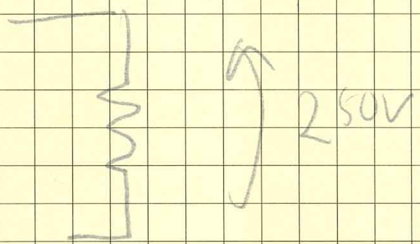
$P_0 = 6250$ kW

pf = 0,5 lagg

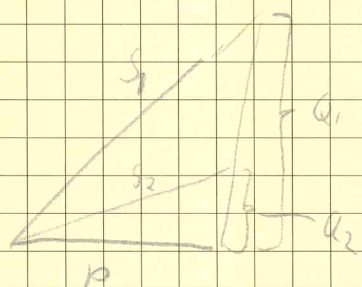


$S_1 = \frac{P}{\cos\varphi} = \frac{6250 \text{ kW}}{0,5} = 12500$ kVA

$Q_1 = \sqrt{S^2 - P^2} = \sqrt{12500^2 - 6250^2} = \cancel{13975}\ 10825,3$ kW

$S_2 = \frac{P}{\cos\varphi_2} = \frac{6250}{0,9} = 6944$ kVA

$Q_2 = \sqrt{S_2^2 - P_2^2} = 3027$ kW



$Q_c = Q_1 - Q_2 =$

$= \cancel{13975}\ 10825 - 3027 = \cancel{10948}\ 7798$ kvar

$Q_c = \frac{V^2}{X_c}$ $\quad X_c = \frac{V^2}{Q_c} = \cancel{\frac{250^2}{10948 \cdot 10^3} = 5,709 \cdot 10^{-3}}$

$X_c = \frac{250^2}{7799 \cdot 10^3} = 8,01 \cdot 10^{-3}$

$X_c = \frac{1}{\omega C}$ $\quad C = \frac{1}{\omega X_c}$

$C = 0,397$ F

This was a very large capasitor.

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2b) A capasitor in parallell makes the load current less lagging, more leading.

An inductor does the oposite.

$S = VI^*$ $\quad$ * conjugate.

That means when I have negative angle. (lags)
the Q is positive.

Trigonometry shows us that $P = VI \cos\theta$ (the real part of S)
and $Q = VI \sin\theta$ (the imaginary part)

In this example the Power P stays the same,
~~That means~~ and Q is shrinking (getting smaller).

That means S also get smaler, ⟹ Since V is the same, and the angle of I got ~~better~~ (close to unity)
this means |I| has to get smaller.

That is very good because the losses = $|I|^2R$

3. a)

We can not always measure all values of voltages, currents and so on... in a system mostly because the measuring devices that measures angles are very expensive. its quite easy to measure magnitudes of voltages and P and Q therefor we have ~~4~~ buses.

PQ bus - measures P and Q

Slack bus - this is a "starting bus" or reference

here we set the voltage to 1pu and the angle to $\angle 0°$.

Generator bus - here we have P and $|V|$.

we can chose Q to get these values

(PV-bus)

~~When we have~~

When we have the Y matrix its very easy to calculate ~~a~~ currents ext.

We use Ymatrix because then we can measure by short sircuitis other buses, ~~[illegible]~~ to ~~a~~ get the other voltages = 0

When we have the Zmatrix we need the I's to be 0, and its more work to open circuit.

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3a continues.

also the Z between busses who don't connect $= \infty$

$Y = 0$

$Y_{12} = 0 \qquad Y_{14} = 0$

b) $Z_{13} = -(0{,}1 + j0{,}3) \qquad Y_{13} = -\frac{1}{0{,}1 + j0{,}3} = -1 + 3i$

$$Y_{nodal} = \begin{bmatrix} Y_{11} & Y_{12} & Y_{13} & Y_{14} \\ Y_{21} & Y_{22} & Y_{23} & Y_{24} \\ Y_{31} & Y_{32} & Y_{33} & Y_{34} \\ Y_{41} & Y_{42} & Y_{43} & Y_{44} \end{bmatrix}$$

$Z_{23} = -(0{,}15 + 0{,}45j) \qquad Y_{23} = -\frac{1}{0{,}15 + 0{,}45j} = -0{,}66 + 2i$

$Z_{24} = -(0{,}1 + j0{,}3) \qquad Y_{24} = \frac{1}{0{,}1 + j0{,}3} = -1 + 3i$

$Z_{34} = -(0{,}05 + 0{,}15i) \qquad Y_{34} = \frac{1}{0{,}05 + 0{,}15i} = -2 + 6i$

$$Y = \begin{bmatrix} +1 - j3 & 0 & -1 + j3 & 0 \\ 0 & \cancel{0{,}66 - 2}\ +1{,}66 - j5 & -0{,}66 + j2 & -1 + j3 \\ -1 + j3 & (-0{,}66 + 2i) & 3{,}66 - j11 & -2 + j6 \\ 0 & -1 + j3 & -2 + 6i & (3 - 9i) \end{bmatrix}$$

$Y_{11} = -(Y_{12} + Y_{13} + Y_{14}) = -((1 - j3) + 0 + 0) = -1 - j3$

$Y_{21} = Y_{12} = 0 \qquad Y_{23} = Y_{32} = 0{,}66 - 2i \qquad Y_{22} = -(Y_{21} + Y_{23} + Y_{24}) = -((0{,}66 - j4) + (1 - j3))$

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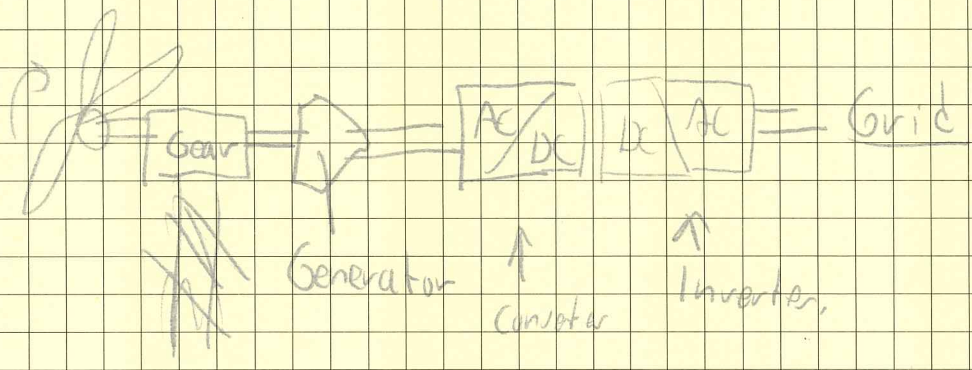
4. b)



Vind blows on the wings, the windmill has gears so that the rpm is higher, it needs to be when it comes to the generator. in the generator the mechanical power ~~is converted~~ becomes AC power.

Because the AC power made by the generator ~~is~~ have very variable quality, it need to be converted to ~~DC~~ ~~p~~ Direct Current. As we know the grid is AC, so the Direct current needs to be inverted back to AC. This time the AC is of much better quality, and can be feeded in to the grid.

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4c) Surge Impedance loading.

The SIL is ~~the~~ the borde of loading which the line ~~delivers~~ uses more reaktive effect ~~to the system~~ than it produses. the $SIL = \frac{kV^2}{Z_c}$

Where $Z_c = \sqrt{\frac{L}{C}}$

The amount of reaktive effekt produce by line : $\frac{kV^2}{X_C}$

The amount of reaktive effekt "used" by line : $I^2 X_L$

The borde : $I^2 X_L - \frac{V^2}{X_C} = 0$

$\Downarrow$

$I^2 X_L = \frac{V^2}{X_C} \Rightarrow I^2 \omega L = \frac{V^2}{\frac{1}{\omega C}} = V^2 \omega C$

$\cancel{I^2} \omega L = \cancel{I^2} Z^2 \omega C \Rightarrow Z^2 = \frac{L}{C} \Rightarrow Z = \sqrt{\frac{L}{C}}$

If the line is loaded above its SIL it pulls (absorbs) Q from the System.

If its loaded below its SIL it delivers Q to the system.

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d)

Load bus is a simple bus where P and Q is known.

Generator bus is a bus where P and |V| is known. in a generator bus we can adjust Q so but P and |V| should the same.

Slack bus is a bus taken as a ~~referanse~~ referans.
when |V| = 1pu and ~~V~~ Vangle = $\angle 0°$

We have to have a referans bus to be able to calculate on the flow. therefor we take a "0" referance. It is not ~~a~~ real $1\angle 0°$, but we set it to be.

I explain more about the buss in 3b)